BOARD OF FIREFIGHTING PERSONNEL STANDARDS AND EDUCATION

Fire Officer Strategy and Tactics

Student Workbook

January 1, 2016

Unit 1-Introduction and ICS

Lesson Goals

When the unit is completed, the student shall have a better idea of how the course will be conducted and who will be teaching. The student will additionally be able to identify the elements of the National Incident Management System (NIMS) which provides a template for the initial incident commander to effectively manage the incident.

All big problems were once small problems. Initial Incident Commanders must make good use out of the information at hand to effect a safe, successfully incident completion. The Incident Command System (ICS) is an important part of safely managing a fireground. The ICS helps incident commanders by giving them a "roadmap" to follow when developing their initial action plans.

Class Rules

Tum your cell phones off, or at least set to vibrate
If you must make a call, excuse yourself from the room
Tum your fire pagers and radios off
Pay attention; get the most out of this you can
Be respectful of guests and other instructors

Evaluation

All activities and scenarios are based on structure fires.
There will be a walk-through activity followed by one or more small group, scenario-driven activities for each area covered.
A final, hands-on scenario will be accomplished at the end of class using the skills learned.

Course Focus

This course focuses on the requirements of an *Initial* Incident Commander. The *Initial* Incident Commander will typically be in charge of the incident for the first fifteen (15) minutes.

Good Initial Incident Commander Traits

It is important for someone wanting to serve in an Incident Commander role to have certain traits. Above all else, being a good initial incident commander means being able to realize your own inadequacies.

Additionally, an effective Incident Commander:
Has a clear understanding of building construction
Has a clear understanding of fire behavior

Understands the different fire and emergency roles and responsibilities
Has the ability to see the "big picture"
Understands when not to go
Remains cool under pressure

Strategy versus Tactics

It is important that we understand Strategy. Strategy sets the overall tone for the incident; further decisions will be based on the Strategy you define in the beginning.

Strategy:

An Incident *Strategy* is defined as a plan of action (POA), the general plan or direction selected to accomplish incident objectives; a fireground strategy would be "Conduct Rescue Operations."

Tactics:

While an Incident *Strategy* is defined as a plan of action (POA), an Incident *Tactic* is defined as how an assignment will be accomplished by a deployed resource. Short-term, specific actions; a fireground tactic would be "Use a ladder to enter a window."

The Incident Management System

Good initial incident commanders will consider the pertinent aspects of NIMS to managing the first fifteen minutes of the incident. While NIMS is used to manage large, long term incidents such as disaster relief and forest fires, it is important that we understand the basic components of NIMS and implement those components so that if the incident grows in severity, we have built a good base to "scale up" our incident response.

We are going to concern ourselves with the first 6 components of NIMS:

1. Common terminology
2. Modular organization
3. Integrated communications
4. Unified Command structure
5. Incident Action Plan
6. Manageable span of control

Common Terminology

In our communications, we should strive to use plain English when communicating. Plain English will assist us in communicating with agencies unfamiliar with any code words used locally.

Modular Organization

Every incident begins with an Incident Commander. No matter how large or small an incident is, it will have an incident commander. On small incidents such as medical calls or simple fire runs, the most senior member or company officer will serve as the incident commander. On larger incidents such as structure fires and auto accidents the incident commander may be formally announced.

As the incident gets bigger, the organizational chart grows. Divisions and groups grow into an operations section, a safety officer is added, a logistics section begins to form. While normally the initial incident commander will not create a massive organizational chart, they must understand how the organizational chart forms and grows.

Integrated Communications

Being able to communicate will have a direct effect on success or failure. In fact, communication (or lack thereof) is usually the first or second bullet point on most NIOSH line of duty death reports. While communicating amongst an initial incident commander's crew is usually not problematic, responding to an incident out of jurisdiction may be quite scary if you cannot communicate in the area to which you are responding. Therefore, it is important that communications problems are resolved before "the big one."

There are many ways that we, as initial incident commanders can communicate; there are state-funded talk groups and locally-shared frequencies. Make sure that you know the plan for communicating *before* the incident occurs.

Ensure that you and your neighboring agencies can communicate with one another.

Unified Command

It's not about who is in charge, it is all about who is in charge of what. Make sure you are including other public safety agency partners in your decision-making process.

Incident Action Plan

Every incident needs an incident action plan (IAP), though most IAPs are not written but rather verbally communicated. Even if written, written IAPs don't have to be elaborate, ornate documents. Simply make sure they effectively communicate the plan.

Manageable Span of Control

Span of control refers to the number of personnel reporting to any given individual. The optimum span of control in the ICS is five, with an acceptable spread of two to seven.

Incident Mapping

It is important to "map" out an incident so that everyone responding is oriented. Using compass directions such as "North or West" could cause confusion to responding agencies. Therefore, in NIMS we use the letters A, B, C, and D to map out a geographical area.

When we are mapping out buildings, we use A, B, C, and D to designate the sides of the structure. This is done clockwise typically starting with the address side of the structure. A-is typically the front of the building and referred to as the "A-Side." Exposures are identified as the side plus a numerical designation. So, the exposure on B would be considered "B1."

Unit 2- Building Construction

Lesson Goals

When the unit is completed, the student shall be able to correctly match terms about building construction with their definitions, identify the different types of buildings, and identify hazards that are related to those building types.

Building Construction

Francis Brannigan, who wrote the world renowned book *Building Construction for the Fire Service*, used to say, "The Building is your enemy; know your enemy!" This unit provides an in depth discussion of building construction and the hazards associated with building construction.

There are two things to always consider:

First, always remember that no matter how hard we try, gravity will always win.
Second, mass equals fire resistance. As we discover in fire behavior, the bigger the material the longer it will take to decompose under fire conditions.

Building Construction Definitions

It is important to understand several terms associated with building construction so that when we discuss how buildings are dissected by the products of combustion we can better understand what is going on.

COMPONTENTS

A ***component*** is any structural element or elements of a building. This could be the walls, floors, balconies, etc.

a. Beams: ***beams***, also called ***rafters***, these components span the length and width of the building holding the upper floors and roof.
b. Columns: ***columns*** extend upward from the floor to the ceiling
c. Walls: ***walls*** come in two basic types: load bearing and non-load bearing

FORCE

Force is any action that maintains or alters the building or its components. There are four types of force.

1. Compression: squeezing or pushing of a component
2. Tension: stretching or pulling of a component
3. Shear: condition causing two structural members to slide past each other
4. Torsion: twisting of a component

LOAD

A ***load*** is weight either designed into a structure or added later. Added later doesn't always mean that the building is able to carry the weight. There are many different types of loads and the way they apply force to a building can create a hazard under fire conditions

a. Dead Lead: A ***dead load*** is weight of the building itself and any equipment permanently attached or built in.
b. Added Dead Load: an ***added dead load*** is a load added to the building after the building has been constructed. Often, these loads were not a part of the original building engineering.
c. Live Loads: a ***live load*** is any load other than dead load. For example, a printing press bolted to the floor in a book-binding factory is a dead load. However, the paper, ink, and other materials are live loads.
d. Impact Loads: an ***impact load*** is a load delivered in a very short time. A building may resist a 1,000 pound dead load but may not resist a 1,000 pound impact load. For example, the World Trade Center towers were designed to hold the floors and all the equipment within, but not designed to withstand the impact of each upper floor as it came crashing down
e. Lateral impact loads: a ***lateral impact loads*** are loads delivered from an atypical direction. Lateral impact loads can be explosions, wind, or vehicles driving into buildings.
f. Environmental Loads: ***environmental loads*** are loads introduced by the environment. They include snow, rain, wind, earthquakes, etc.
g. Concentrated loads: ***concentrated loads*** are loads that are located at one point in a building. Concentrated loads can include air conditioning units, large machinery, or heavy safes.
h. Axial loads: ***axial loads*** pass through the center of supporting members.
i. Eccentric loads: ***eccentric loads*** are imposed off center of the member.
j. Torsional loads: ***torsional loads*** are imposed at a right angle to a supporting member, creating a twisting force

Building Construction Materials

There are many materials that are used to build buildings. Some of these materials include (but aren't limited to):

- Wood
- Steel
- Concrete

Building Materials - Wood

Most of the structure fires that initial company officers will be faced with will be found in wood-framed structures.

Wood is combustible, which means when fire involves the structural components of a building, collapse becomes a very dangerous likelihood. Wood construction inherently creates void spaces where fire can secretly travel. Inhibiting fire spread within a structure can be accomplished through building techniques. Other forms of fire stopping available are not as common. For example, wood cannot be made fireproof; fire retardant can be produced by impregnation of the wood with mineral salts, but it is very expensive. Similarly, a surface coating such as paint can be used to reduce flame spread, but again, the costs outweigh the benefits.

Newer construction uses lighter, thinner wood called "engineered wood." In engineered wood, pieces of wood sliced into thin layers and glued or spliced together with metal connections. Many times under fire conditions, the glue or metal will weaken and increase the chance of collapse. Additionally, because newer construction uses lighter, thinner wood, fire spread and collapse will be more rapid than in older structures.

Building Materials- Steel

Up until recently, steel was used on most building projects. Nowadays, the rising costs of steel have forced builders to revert to using either wood or concrete.

Steel has an impressive compressive and tensile strength; therefore smaller diameter steel is used in comparison to wood. Unfortunately, while smaller steel is stronger than wood of the same dimension, light-weight members have little inherent fire resistance and will fail rapidly.

As a rule of thumb, unprotected steel begins to distort and lose strength at 1,000°F (538°C). Therefore, when exposed to temperatures above 1,000°F (538°C) unprotected steel will expand and twist.

That being said, different sizes of steel are used in structures; for example, elevator cables fail at 800°F (427°C) degrees and excavation tiebacks will fail at similar temperatures. Due to the decreased surface-to-mass ratio, the critical temperature for steel trusses is 1,000°F (538°C).

In regards to heated structural members, when possible, let out the heat through good ventilation practices or apply water to the steel members. Water applied to steel will stop the elongation or buckling

Unlike wood, steel structural members and components can be fireproofed in several ways: Spray on fireproofing
Encasement in drywall or another material

Metal deck roof fire

One type of fire that is unique to steel buildings is the threat of a metal deck roof fire. Metal deck roofs consist of metal sheets laid over steel bar joists and when a fire occurs below a combustible metal deck roof the metal deck heats up. This causes the adhesive to liquefy and then vaporize. The gas cannot escape through the roofing material, so it is forced through the decking. When the gas mixes with the air below, it ignites creating a fire that is difficult to access and extinguish.

One final note on steel construction materials: buildings aren't the only thing built with steel; car and semi fires can adversely affect the structural integrity of a bridge or overpass.

Building Materials - Concrete

Concrete is used in most construction and has impressive compressive strength at a relatively low cost. Concrete is used in:

- Floors
- Walls
- Ceilings

Unfortunately, while concrete has its good qualities, it has two major weaknesses: First, in order to achieve maximum strength, untreated concrete will require 21 days to cure. This means that construction sites where concrete buildings are being created may have a lower overall structural integrity. Secondly, while concrete has great compression strength, it has little tensile strength.

In order to increase tensile strength, metal rods or cables are strung within the concrete as it is laid. Concrete is used in columns with steel reinforcing rods for eccentric or torsional loads. This allows the concrete column to be able to withstand loads and forces put upon it from the sides. Concrete beams can be created using post-tensioned cables. Post-tension concrete is created when concrete is poured on site or in a mold with cables stretched within. These cables are then put under tension, to give the concrete torsional strength

When constructing columns, beams, ceilings, and walls, there are two basic types of concrete construction

- Cast in place
- Precast concrete

Cast in place concrete construction

When concrete cast in place construction methods are used in buildings, a false work created to support the concrete as it cures. This false work is often made of wood treated with chemicals and will bum away, creating collapse hazard.

Pre-cast concrete construction

In pre-cast concrete, parts of the building such as the walls, columns, or beams are built in a different location and then shipped to the construction side. Pre-cast is very prevalent in highway bridge construction. One of the most common places pre-cast concrete is found is called tilt-slab construction. Here the framework of the building is put in place and non-load-bearing walls are literally "tilted up" and connecting to the framework.

Under Fire Conditions

While concrete in itself will not bum, the components used to make it stronger can be affected by the products of combustion.

False Work Fire

False work, which is usually nothing more than a treated lumber yard in the sky can bum, causing collapse.

Spalling occurs when concrete is heated and the moisture expands within concrete causing fractures and chips to flake off. This will cause the metal framework to become exposed.

Tensioned framework within concrete will not elongate until it is exposed to fire. When this happens, concrete can lose strength (compression or torsion)

Building Construction

Traditional building construction is broken into 5 Types:

- Type **I** – Fire Resistive
- Type II – Non-combustible
- Type III – Ordinary
- Type IV - Heavy Timber (or Mill)
- Type V - Wood Frame

Each building will react differently to fire and smoke spread, and it is important to know the different characteristics of each.

Type I - Fire-Resistive Construction

A Fire Resistive constructed building, in a nutshell is built not to burn. All structural components of the structure are protected in some way from the products of combustion. These structures are typically mid- and high-rise structures with high-occupancies. Most of the time fires encountered in these buildings will consist of only the contents.

As stated before, all the structural members that could be involved in fire are usually wrapped in some form of protection. Whether it's concrete, sheetrock, or spray on insulation, the structural members are protected from the products of combustion very well.

Older buildings were constructed of concrete and steel with a focus on concrete while new buildings are constructed of steel and concrete with a focus on steel. One unique aspect of newer fire-resistive buildings is the use of *curtain walls.* A curtain wall system is an outer covering of a building in which the outer walls are non-structural, but merely keep the weather out and the occupants in.

While the structural members of Type 1 Fire-Resistive constructed buildings are protected, fire and other products of combusting can still travel within the structure several different ways:

- HVAC systems
- False Floors and drop ceilings Elevator shafts
- Compactor and incinerator shafts
- Access stairs

Most Type I Fire-Resistive constructed buildings are massive; once a significant fire gains a foothold, initial incident commanders should be concerned with large, open floor plan typical of an office complex, maze-like conditions created by cubical spaces, long distances between fire protection systems, stairs and elevators, difficult access to areas of the building and spalling concrete.

Building Systems

One of the initial incident commander's first concerns is gaining control of the building systems. It is imperative that the initial incident commander gain control of:

- HVAC systems
- Elevators
- Fire Pumps

Type II-Non-Combustible / Limited Combustible Construction

Non-Combustible / Limited Combustible Construction is very similar and often mistaken for one Type I. However, unlike Type I– Fire Resistive, in Type II– Non-Combustible / Limited Combustible Construction the walls, floors, and the roof support system (including the roof deck) are all made of non-combustible material.

When you consider the stability of all the current types of construction, Type II- Non-Combustible / Limited Combustible constructed buildings are the least stable when exposed to the products of combustion.

One of the greatest hazards to collapse in Type II- Non-Combustible / Limited Combustible construction is the use of open, web-steel bar joist. These bar joists, often spaced widely apart, have no fire resistance rating and under fire conditions, will fail within five to ten minutes. As a rule of thumb, unprotected steel begins to distort and lose strength at 1,000°F (538°C). However, due to the decreased surface-to-mass ratio, the critical temperature for steel trusses is 1,000°F (538°C).

Often, through the desire for aesthetics, these buildings will have large overhang and false facades. These facades will allow fire to spread from occupancy to occupancy unnoticed.

Initial Incident Commander Considerations

Most of the buildings are used in manufacturing and commercial occupancies. The most common types of newer, commercial construction include:

- Strip malls
- Mechanic Shops
- Warehouses
- "Big Box" Stores

There will be large, open expanses that will allow the products of combustion to spread unimpeded. Additionally, since many of these buildings have a non-subdivided attic or cockloft space, *or* the fire stopping in these spaces are compromised, products of combustion will spread very quickly and often un-noticed. These characteristics will create a major problem in attempting to confine and extinguish the fire.

Contents within these structures will determine the fire load and consequently, the hazard. Heavy content fuel loads are a particular concern. However, the most effective defense against heavy content fuel loading is proper inspection and code enforcement.

The initial incident commander should early on consider the use of large, smooth-bore lines for fire attack. The initial incident commander, when faced with a working fire within a building of this type should call for extra manpower early in the incident.

TypeIII-OrdinaryConstruction

Ordinary Construction can be best described as "Main Street U.S.A." It is given this designation because most downtown areas throughout the state of Indiana are lined with Type III -Ordinary constructed buildings.

These buildings were built around the tum of the twentieth century and have masonry bearing walls which often will run perpendicular to the main street. The walls parallel to the street will most likely be non-load bearing. However, it is these non-load bearing walls along the street front that contain parapets, ornate building features and marquees that will create collapse hazards during a fire.

On the interior, simple wood beams are used to span from load bearing wall to load bearing wall. These beams will be up to 25' in width. Longer beams will require steel "I" beams, columns or interior masonry walls. In Type III- Ordinary Construction, un-renovated interior structural members are usually made of wood. Roofs are made of wood planking covered with tar paper and then hot tar. Over the years, many roofs have been added, and it won't be uncommon to find that some roofs may have 8" of layering after several decades.

Type III- Ordinary constructed buildings will have a *cockloft.* The cockloft is the space above the ceiling and below the roof boards. This space can be several feet high, but will be an un-livable space (unlike an attic). This area is often made of combustible materials and can be the scene of high carbon monoxide levels, which can reach explosive levels.

In some instances, owner **/** occupants rather than repair a leaky roof again, have elected to build a secondary roof over the old structure. These are called *rain roofs.* This creates a nightmare for trying to vent the structure.

These buildings were built with very ornate features. These features, such as parapet walls, and cornices can easily be knocked off by aerial ladders or masters streams, or simply fall off the building after years of weathering.

Initial Incident Commander Considerations

Unless compromised during renovation, exterior walls will limit fire spread from one building to another, but interior walls will give little to fire resistance. The major fire spread problems in these buildings are in concealed spaces and in the numerous spaces from floor to floor. Fire will spread *vertically* and *horizontally.* Vertically, fire will spread through vertical channels including**: stairways, elevator shafts, and dumbwaiters.** Horizontally, fire can spread through horizontal channels including **hallways, corridors, and cocklofts.**

Through the years, buildings have been repurposed and renovated. Often during the renovation process there have been major changes that the initial incident commander should consider:

- Building has been connected to neighboring building
- Air and light shafts; some structures will have air and light shafts between buildings. (Often times, during the roofing process, these shafts may be covered by lazy roofers.)
- Parapet walls and marquees; these structures are often tied to the front of buildings with little support. In addition to the collapse hazards they pose, void spaces behind them will allow the products of combustion to spread unchecked.
- Building stability: when these buildings begin to show their age, tiebacks will added to assist with keeping the floors level. If you see "stars" on a building, you must question the building stability.

Fire Cut beams

These structures were originally built to bum. When they were originally constructed, firefighting and construction methods were not as they are today. Therefore, these buildings were built in such a way that the interior floors and walls would collapse leaving the exterior side walls intact. When older buildings were built, it was more important to keep the walls up than it was to maintain the floors. Having the walls remain standing not only created fire breaks, they also meant that heavy equipment and scaffolding was not going to be needed to rebuild the wall. To assist the floors in collapsing, beams were purposely cut at an angle to allow for early collapse.

Type IV- Heavy Timber

Heavy Timber construction is similar to Type III- Ordinary Construction, but can more appropriately be considered "Ordinary Construction on Steroids." Like Type III- Ordinary Construction, exterior walls are usually masonry in construction, but the interior lumber dimensions are staggering. Columns must be at least 8" x 8" in diameter and girders and joists must be at least 6" x 10" in diameter.

Initial Incident Commander Considerations

Most fire and smoke spread issues are the same as Ordinary construction. However, given the dimensions of the interior structure, the fire will literally chase you out before the building collapses.

While this type of construction is not prevalent in most of Indiana, it can be found in some of our older communities, especially those that had mercantile, railroad, or textile businesses. Today, many of these buildings that still exist have been converted to apartments, so in addition to the large expanses presented; a new hazard in the form of high-occupancy has been created.

Bowstring Truss Construction

Bowstring truss construction is common in both Type III- Ordinary Construction and in Type IV- Heavy Timber Construction. Bowstring truss roof structures allowed for a large expanse within the structure when needed. Bowstring truss roofs have a distinct hump shaped roof, and the trusses can be ten- to twenty- feet apart. The initial Incident Commander must be on the lookout for these types of roofs, as they are dangerous to operate on and under. Often, parapet walls or marquees have been constructed to hide the "hump" from the street. Bowstring trusses collapses have been a leading cause of firefighter fatalities, and these trusses will often fail within ten to fifteen minutes of being subjected to fire conditions. In addition to their own collapse hazard, the initial Incident Commander should also be aware of the exterior walls collapsing as the trusses push outward.

Type V- Wood Frame Construction

Wood-Frame Construction will be the most common type of construction seen by firefighters today. Type V- Wood-Frame Construction consists of exterior walls, interior walls, ceiling, floors, roofs all made of combustible materials. The exterior features of a Type 5 – Wood Frame constructed building could be covered with a brick veneer. The initial incident commander should not take a building's brick exterior to mean that the building is constructed with a masonry bearing wall.

The majority of structures that are Type V- Wood Frame Construction are residential. According to NFPA data gathered from 1994 to 2003, line-of-duty deaths (LODDs) due to structural collapse incidents occurred most frequently in residential occupancies.

Wood frame buildings have several collapse hazards. Since the entire structure is made of wood, any part of the building can fail during an assault by the products of combustion. To name a few:

- The curtain wall can separate from the building and fall straight out
- The entire building may "lean over"
- Inward-outward collapse; this is the most dangerous situation where the upper floors fall inward kicking the lower floors outward.

In Type V- Wood Frame Construction, wood is used to carry the major structural loads. There are many different ways a Type V- Wood Frame structure can be build. However; we are going to break this down into three basic types:

- Post & Beam"
- Balloon Platform

Post and Beam

Post and beam is the oldest form of wood frame construction and can be seen along Indiana's roadways in the form of old, dilapidated barns. Post and beam buildings were built before the 20th century by expert craftsmen. The buildings were held together by vertical posts and horizontal beams. Buildings such as this will have inherent fire stopping between floors, but the open stairwell system will allow the products of combustion to extend from one floor to another. Additionally, like Type III and Type IV buildings, dumbwaiters and air/light shafts could be expected.

One of the major structural problems of all wood-frame construction is that the dimension of the first floor lumber is the same as the top floor lumber. So, lower floors lack the mass to withstand the products of combustion. A significant first-floor fire will have a dramatic effect on the structural integrity of the building.

Balloon Frame

Balloon frame construction consists of wood framing system in which studs go from the foundation of the structure to the roof. Balloon frame construction can be recognized by windows in line with each other. This is similar to post and beam however, these structures have are no inherent fire stopping between floors. A fire in the basement could present itself in the attic space if void spaces are not checked. Additionally, like Type III and Type IV buildings, dumbwaiters and air/light shafts could be expected.

The most recent type of building construction is called *platform frame*. Platform frame consists of one wood-framed floor built on top of (or next to) another platform. This method of construction will help confine the fire to one floor. Unfortunately, any utilities such as HVAC, cable, or internet services may negate this confinement when wires are passed from one platform to another.

New buildings are "built cheap" many times there is nothing between the sheet rock and the vinyl siding but a piece of Styrofoam. These structures will consist of lightweight trusses.

Initial Incident Commander Considerations

In Type V- Wood Frame Construction, fire spread within these structures is very problematic. Literally the entire building is combustible. Many times the problem with wood frame construction is the combustible exterior. Fire that extends out a window or doorway will quickly travel up the combustible exterior and threaten to auto-extend into upper floors. If the structure is located close to similarly-combustible structures, one building fire will quickly tum into two or three. The initial incident commander must place hoselines in anticipation of the fire spread.

Internally, control of the products of combustion isn't much easier. The open design of even the newest homes allows fire and smoke to spread throughout the structure without being stopped. Vaulted ceilings will mask the significance of the fire by allowing heat to collect high above the fire and occupants below. Non-standardized layouts and / or unauthorized renovations will only serve to confuse firefighters and delay fire suppression.

Modern Lightweight Engineered Construction Considerations

Today's building techniques focus more on engineering and geometry than on the survivability to the products of combustion. Because of cost considerations, buildings today are literally "built cheap." This isn't to say that newer buildings are not safer than older buildings; today's building techniques create very strong structures with half the materials of older counterparts. Modem buildings have more square feet for less money, more energy efficiency and are better insulated. However, these buildings contain more hydrocarbon products, contain less mass and are less compartmentalized (leading to hotter and quicker fire spread and collapse).

There are numbers of engineered wood products, including:

- Parallel Chord wood trusses
- Plywood "I"-Joists
- "I" Stairs

All initial or potential incident commanders should be aware of a number of aspects of modem lightweight engineered construction.

Parallel Chord Lightweight Wooden Trusses

Parallel chord wooden trusses can be found in both roof and floor construction. Like other wood structural members parallel chord trusses will hold their load until the last second and cause a rapid catastrophic failure with little or no warning. Parallel chord wooden trusses are extremely dangerous when assaulted by fire. Like other truss structures, these trusses can be placed great distance from one another. Unlike traditional roofs, failure of one truss could lead to failure of a large section of the roof.

These trusses are created using 2" x 4" Dimension Lumber joined together with gusset plates. A gusset plate is a square or rectangular piece of sheet metal that has numerous barbs. These barbs are nailed into several pieces of wood to join them together. Under fire conditions, these gusset plates will act as a heat sink and / or literally pull away from the wood it is joining together.

Between the parallel chord trusses are truss lofts. Truss lofts are the open areas created when truss floors or roof structures are used. These truss lofts are open end to end, side to side. Many times these lofts are not sealed, or if they are sealed, utility chases and HVAC construction will break the barriers within. Truss lofts create hidden void spaces and can fail in as little as 80 seconds.

Plywood "I" Joist

Plywood "I" Joist are engineered lumber typically found in new and renovated structures. While they are usually used in flooring, they can be used elsewhere in the structure. These structural members consist of a top chord; bottom chord (usually 2" x 3" laminated flanges); with plywood or oriented strand board (OSB) between. Lengths of plywood "I" joists can be up to 60 feet and expect large cutouts for utilities between the joists.

Collapse can occur quickly (in as little as four minutes) as the web, OSB, or plywood will bum away leaving the bottom and top chord to support the load.

"I" Stairs

"I" Stairs are constructed using 2x4s for the main support. Along the 2x4, a lightweight metal frame creates a channel for the tread and riser. A gusset plate, similar to truss gusset plates holds the stair riser and tread in place. The entire stair assembly is manufactured in a factory and shipped to the jobsite.

Collapse Hazards

Any building under fire conditions can suffer a catastrophic collapse. However, structural collapse becomes very likely in the decay stage when the products of combustion have significantly impacted the structures ability to resist gravity. Additionally, 8.33 pounds (3.69 kilograms) of water is added to the weight of floors for every gallon of water applied during fire department suppression operations. These two dynamics (significantly impacted structural integrity and large amounts of water delivered into the structure) can have a negative impact on the structural integrity.

Additional collapse factors include the renovations, age of the structure, weather and loads. Incident commanders must establish collapse zones around the structure when defensive strategies are adopted. These collapse zones should be adjacent to any exposed exterior walls.

If needed, personnel may cautiously place an unstaffed master stream in the collapse zone when the incident commander deems it vital, and a collapse may be imminent.

Energy Efficient Modern Construction

As new technologies become more cost-effective, new construction techniques take hold. Below are a few new construction techniques that have been found throughout Indiana:

Insulating Concrete Form (*ICF)* is a system of formwork for concrete that stays in place as permanent building insulation for energy-efficient, cast-in-place, reinforced concrete walls, floors, and roofs.

Structural Insulated Panel (SIPs)

The most common Structural Insulated Panel is a composite structural panel with an insulating core of rigid foam (usually EPS or polyurethane) and structural facings; most commonly of 7116" thick oriented strand board (OSB).

Solar Power

In addition to energy efficient building, more and more structures are being built with some form of energy production. One such energy production is solar power.

There are three basic types of photovoltaic (PV) modules:

1. Framed Panels; where the modules are placed on a roof in frames
2. Building Integrated Photovoltaics (BIPV); where the modules are placed into the actual structure such as along an exterior wall
3. Flexible Laminate; a lightweight, flexible solar electric system designed to serve a dual purpose of roofing and power generation. It is has been touted an ideal solution for new construction or re-roof situations.

Unit 3 Fire Behavior

Lesson Goal

After completing this lesson, the student shall be able to explain the science of fire behavior as it relates to recognizing stages of fire development, rapid fire behavior, and firefighting operational safety.

Introduction

Fire has been both a help and a hindrance to mankind throughout history. It has heated our homes, cooked our food, and helped us to become technologically advanced. In its hostile mode, it has endangered us for as long as we have used it.

Physical Science

As initial incident commanders, it is important to understand exactly what fire is, and more importantly what it will do if allowed to grow unimpeded.

The most direct definition of fire is "a rapid chemical reaction that gives off energy and products of combustion that are very different in composition from the fuel and oxygen that combined to produce them." When a substance changes from one type of matter to another, it has had a chemical reaction.

Matter can have two different types of changes: physical changes, such as freezing or boiling water or chemical reactions such as hydrogen and oxygen combining to form water. The initial incident commander should know that reactions give off energy. An exothermic reaction releases energy in the form of heat and sometimes light.

One of the most important exothermic chemical reactions related to fire development is *oxidation.* Oxidation is important because it will allow a fire to grow without oxygen. Some oxidation is very slow, such as your truck slowly rusting in the driveway. Some oxidation, such as a flammable liquid fire can be quite rapid.

Fire triangle and tetrahedron

Passive agents and heat are the elements necessary to create fire in the model represented by the fire triangle. Fire triangle and later the tetrahedron were important educational developments that helped initial incident commanders understand what it takes for a fire to develop. The chemical reaction that we know as fire takes four parts (three for the triangle) to develop;

- A heat source
- A fuel
- A oxygen source or oxidizer (the primary oxidizing agent in most fires is oxygen)
- A chemical reaction

In addition to light, one of the most important byproducts of fire is heat. Understanding how heat transfers from the point of origin to other objects is beneficial to an initial incident commander. By understanding this, the initial incident commander can develop plans to prevent or stop fire spread.

Heat will move from warmer objects to cooler objects. There are three ways that heat is transferred; conduction, convection, and radiation.

Conduction

Movement of heat directly from one object to another object
-Example: heated floor felt through firefighters' gloves as they crawl along

Convection

Movement of heat through a fluid (or specifically, hot smoke and other gases)
-Example: heated air moving away from the fire into another room

Radiation

Movement of heat through a type of electromagnetic radiation called infrared radiation -
Example: heat from the sun travels through the vacuum of space to heat earth
-A more fire department-specific example would be a major fire heating a nearby exposure a significant distance away.

Now that we understand how heat is transferred, we must understand how heat grows and releases more heat. *Heat of combustion* is the total amount of energy released when a specific amount of fuel is oxidized. A better explanation would be that heat of combustion is the total amount of heat that can be released by an object when it is burned. Materials possess a given amount of potential energy. Heat of combustion is expressed in kilojoules/gram (kJ/g).

-A bottle rocket has a lower potential energy than a stick of dynamite
-A stick of dynamite has higher potential energy than a bottle rocket

Another important metric an incident commander should know a fuel's *heat release rate (HRR)*. Heat release rate is usually expressed in British thermal unit (Btu). Fuel type affects heat release rate. For example, a new sofa will release much more energy than a cotton mattress. This is important for an initial incident commander to understand in order to gauge how large a fire will become based on the fuels involved.

So, we understand how heat is transferred and understand the potential energy of a fuel, finally we must understand how the physical arrangement of the fuel plays into the situation.

Physical arrangement of fuel will play major role in fire development. We have all seen how long it takes a large wood log in a fire place takes to burn as compared to a small twig.

It is also important to consider that heated gases will rise to a point where it cannot rise anymore. In a fireplace, this means that the heated gases will travel up the chimney and out the flue. Unfortunately, unless there is a natural opening in a structure, the fire, *or* someone creates an opening in the structure the heated gases will rise to the ceiling level and remain there growing ever hotter.

General Products of Combustion

The general products of combusting include heat, smoke, and light.

Heat

Heat will have the most impact of firefighters. Nevertheless, heat will also have an impact as it will help the fire spread to other locations of the container. Heat may cause bums externally and internally. Without protective clothing and respiratory protection, heat *will* cause bums and other health issues.

Smoke

Smoke contains a wide range of irritating substances that can be deadly. Smoke causes the most fire deaths in one of two ways; first, within the smoke are toxic byproducts of incomplete combustion. Second is the heated gases within that will bum lung tissue if exposed. This is why firefighters must use SCBA when operating in smoke.

Smoke velocity is influenced by the size of the fire; the size of the openings in the structure; the size of the compartment the fire is located in.

Smoke must be considered fuel. Within smoke, fuel vapors mix with air to the point of combustion. Vaporization defines the minimum concentration of fuel vapor and air that will support combustion. One of the most deadly gases found in smoke is carbon monoxide (CO). In addition to its toxic qualities, carbon monoxide can collect in hidden areas until it reaches flammable levels. This is because of carbon monoxide's very wide *.flammable range.*

A gas' flammable range is the points where the gas is either too rich or too lean to bum (there is too much or not enough of the other elements of the fire tetrahedron). The flammable range can also be thought of as the *Neutral Plane.*

The importance of the neutral (plane) zone!
The interface of the hot and cool gas layers at an opening is commonly referred to as the neutral plane. Neutral zone is where the action escalates the path into "hostile fire behavior" which raises the risk of anything and/or anyone in that path.

Stages of Fire Growth

Fire grows in four stages: incipient, growth, fully developed and decay.

During the incipient stage, the fire is just beginning. The fuel is heated, off gases, and those gases bum. As the fuel is consumed, more heat is created and the fire grows. The neutral plane in the growth stage is the opening in the hot and cool layers. This will allow victims or potential victims to self-rescue.

During the growth stage the fire consumes the fuel of origin and heats objects and surfaces nearby to the point of off-gassing. The neutral plan will gradually lower until it is just above the floor level. Once the neutral plan is at the floor it is highly unlikely that victims will be viable. Growth reaches its peak when all surfaces, objects and even the gases within the compartment are on fire. At this point the fire begins its decay stage.

During the decay stage, the fire has used up much of its fuel source and ***l*** or oxygen and begins the down-ward spiral to being snuffed out. Keep in mind that it is during this stage that there may be enough heat and fuel left within the compartment awaiting a quick breath of oxygen. A sudden introduction of oxygen would allow for a backdraft within the compartment.

Factors that Affect Fire Development

Thermal properties of the compartment (the area of fire origin) can contribute to rapid fire development; make extinguishment difficult and re-ignition possible. Also, how insulated the building or compartment is will affect fire growth. A compartment with good insulating properties (as found in a lot of new construction) will contain heat within compartment causing localized increase in temperature and fire growth. Another property would be heat reflectivity or the amount of increased fire spread through transfer of radiant heat from wall surfaces to adjacent fuel sources. Finally, heat retention or the ability of a compartment to absorb and release large amounts of heat slowly or the inability of a compartment to release the heat to another area will maintain the internal compartment temperature.

There are two forms of compartment fires;

Fuel controlled- sufficient oxygen available; characteristics, configuration of fuel control development.

Ventilation controlled- the availability of oxygen and the configuration of fuel begins to limit fire development in compartment fire.

In today's fires, all fires should be considered ventilation controlled.

Signs of Ventilation Controlled Fire:

- You can't see through windows
- Inside surface of windows look fuzzy
- Anything on inside of windows is burned/heat damaged

- Exterior doors and windows warm/hot to touch
- TIC shows residual heat on doors and walls
- Soot/smoke stain around exhaust openings
- Thermal column reported/not seen while responding
- Witnesses claim there was lots of fire earlier but NOTHING SHOWING upon your arrival!!

Hostile Fire Behavior

There are three basic types of hostile fire behavior.

Flashover

The definition of flashover is: ignition of combustibles in an area heated by convection and radiation. Rapid fire development happens when all the combustible materials and gases in a compartment ignite almost simultaneously. Transition in fire development is a common element of flashover that represents the shift from growth stage to fully developed stage.

Backdraft

Backdraft is defined as an explosion of accumulated fire gases (smoke) generally caused by admitting air into a superheated environment.

Smoke Explosion

Smoke Explosion is where a pre-mixed 'pocket' or 'layer' of fire gases (in smoke), that are already within their flammable range ignite on coming into contact with an ignition source. Smoke Explosion differs from a Backdraft because it is not necessarily an oxygen starved fire; rather, it is the introduction of an ignition source.

FIRE TRAVEL PREDICTIONS

The initial incident commander must be able to understand what stage the fire is in and be able to predict the fire, smoke, and heat travel as determined by:

- Building construction
- Building layout
- Fuel load
- Built-in fire protection
- Air-handling system
- Fire department ventilation efforts

FIRE EXTINGUISHMENT THEORY

The fire extinguishment theory is that extinguishment is done by limiting or interrupting one or more of the essential elements in the combustion process. For example, a fire may be extinguished by reducing the temperature, eliminating fuel or oxygen, or stopping the selfsustained chemical chain reaction

Temperature Reduction

One of the most common methods of fire control/extinguishment is simple temperature reduction. This technique depends on reducing temperature of fuel to point of insufficient vapor to bum. Solid fuels and liquid fuels with high flash points can be extinguished by cooling many times by the use of water. Water is most effective method for extinguishment of smoldering fires but enough water must be applied to absorb heat generated by combustion. Keep in mind that cooling with water cannot reduce vapor production enough to extinguish fires in low flash point flammable liquids/gases.

Fuel Removal

Through the use of fuel remove, we are effectively extinguishing any fire by taking away any further material to bum. At its simplest, we allow a fire to bum until all fuel has been consumed. Another great example of fuel removal is removing logs from a fireplace. Once you rob a fire of its fuel source, it can only grow within the confines of what is on fire and bums itself out.

Oxygen Exclusion

Oxygen exclusion reduces fires growth and may totally extinguish the fire over time by removing the oxygen by either limiting the air supply to the fire or through smothering the fire by some means. Limiting a fire's air supply can be a highly effective fire control action.

Chemical Flame Inhibition

Some agents such as some dry chemicals and halogenated agents interrupt the combustion reaction and stop flaming. This is effective on gas and liquid fuels because they must flame to bum. Chemical flame inhibition is the most common method used in firefighting operations.

SUMMARY

The fires of today, and tomorrow, require much more tactical patience and reserve, than those of yester-year. Fire service personnel of all ranks must understand, recognize, and react to the modem fire ground. The preservation of life, both theirs and ours, is dependent on fire ground effectiveness.

ADDITIONAL RESOURCES

http://cfbt-us.com/ http://ulfirefightersafety.com/
http://www.nist.gov/fire/
http://modemfirebehavior .com/
http://firedynamics.frretrainingtoolbox.com/
http://www .frretactics.com/

Unit 4 Decision Making / Risk Management

Lesson Goal

Former President and General Of the Army Dwight D. Eisenhower once said, "Making decisions is of the essence in leadership."

Incident scenes are dynamic events and the possibility of change is ever-present. As an initial incident commander, one must attempt to predict these changes and react to them. The initial incident commander must be prepared to be one step ahead of these problems. This chapter will help guide initial incident commanders and potential incident commanders to on how to develop decision making skills. Through strategy, tactics, and tasks, we achieve our goals as determined by the incident priorities.

This material was developed out of the National Fire Academy Curriculum.

Decision Making

Incident Scene decision making

There are many decision making models, but for this discussion we will work off of two basic methods, The Classical Model and Recognition-Primed Decision Making (RPDM) model.

The Classical Model

The Classic model is used in most of our day-to-day decision making. Classical decision making follows a specific sequence of steps. It is prescriptive in that it focuses on how decisions should be made and assumes the decision maker is completely rational (i.e., seeks to maximize the payoff and utilizes a search process that proceeds in a planned, orderly, and consistent fashion) and unbiased. The classic model also assumes that the decision maker has available all of the information needed to make a decision and that all possible alternatives are considered, and that the decision maker will select the optimum or best choice.

Decision making proceeds through the following sequence of steps:

1. Problem identification
2. Development of criteria against which alternative solutions can be evaluated
3. Identification of alternative courses of action
4. Evaluation of alternatives
5. Selection of the best alternative
6. Implementation

This form of decision making is great for day-to-day decision making and for making decisions in situations in which we do not have a prior experience.

Recognition-Primed Decision Making

The classic model assumes that the decision maker has all the information, something that most initial incident commanders don't have the luxury of having. Research has shown that most experienced incident commanders use Recognition-Primed Decision Making (RPDM) rather than the classic model.

When using RPDM, the initial incident commander's brain automatically associates past experiences with current events. The brain uses "cues" obtained from their base of knowledge to help make the decision. For example, using RPDM, the initial incident commander on a structure fire references previous structure fires that they have personal experience of and establishes a course of action based on those previous experience.

This method is extremely rapid, but it isn't without shortcomings. For example, in order for an incident commander to make a decision, they must have prior experience with that type of incident. Because of the vastly different responses emergency personnel make, it would be very difficult for an incident commander to have experience with every type of emergency.

Command Sequence

There are five levels of command
- Level 1: Incident Priorities
- Level 2: Size-Up
- Level 3: Strategy
- Level 4: Tactics
- Level 5: Tasks

Level 1: Incident Priorities

In Level 1, the initial incident commander will make the determination of incident priorities. Incident priorities are the foundation of the command sequence and all actions are based on these priorities. Done in conjunction with their size up of the incident, these priorities will be the basis for the development of strategy and tactics.

Every incident has four priorities, though most incidents will only deal with the first three.

Incident Priorities:

Priority 1-Life Safety
Priority 2-Incident
Stabilization Priority 3-

Property Conservation
Priority 4 - Incident Recovery

Priority I - Life Safety

Life safety is always our number one consideration. It includes:

Endangered civilians
Responding firefighters and other public safety personnel responding to the scene

Priority 2 - Incident Stabilization

Incident stabilization means keeping the incident from getting any bigger than the current situation. The actions will vary depending on the type of incident.

Priority 3 - Property Conservation

Once we've stopped the incident from getting worse, we must minimize the amount of property damage emergency personnel are causing. Property loss reduction benefits both emergency crews and building owners. This can be achieved through:

- Quick extinguishment
- Good salvage methods

Level 2: Size-Up

Size-up is the gathering of information about the incident that aids the IC in the development of strategic goals. Size-up is a mental process of weighing all factors of the incident against the available resources. An initial incident commander must weigh the incident they are presented with against the resources responding.

So the question becomes when does size-up begin? Size-up begins as far back as the preplanning stages and continues throughout the incident. Upon arrival the initial incident commander should either complete or have completed a 360 degree walk around the incident if feasible. The initial incident commander must also work to discover all the pertinent information from witnesses and building occupants.

Size-up conducted by the initial incident commander or the company officer will differ because of time constraints. Unlike a later incident commander, the initial incident commander has a need for action and has to make an immediate decision about the volume and severity of the incident and determine the initial strategies and tactics to be deployed.

The chief officer has certain advantages while performing size-up in that they will have slightly more time and will benefit from information provided by the initial incident commander. To assist the later arriving or more superior incident commander, it is important for the initial incident commander to perform an effective and thorough size-up.

One of the ways the initial incident commander can help other responding resources is to give an efficient and effective initial radio transmission of the conditions on the scene. This initial radio transmission must be concise and to the point. It must be transmitted calmly and clearly, and WILL set the tone for the rest of the incident.

What is included in the size-up?

Be(ore you initiate your size-up, contact dispatch and make sure they are listening!!!

Your apparatus/unit designation
On the scene at [dispatched address]
Structure information (dimensions, # of stories)
Occupancy type (residence, hotel, office building)
Incident conditions

- Nothing showing
- Smoke showing (light, heavy)
- Location of smoke (where is it coming from)
- Fire showing (where is it coming from)
- Establish command (designate incident name)
- Identify your next actions (laying a line, attack, search, etc.)

Dispatch, Engine 1 is on the scene at 123 Main St. We have a large two-story residence with smoke showing from a second floor window on the Alpha side of the residence. Engine 1 will be Main St. command We will be stretching a line to the second floor to attack the fire.

Through size-up, we must attempt to learn:

- Where is the fire located?
- Is it confined?
- Where is it going?
- What is the life hazard to civilians and firefighters?
- What is the type of construction?
- What are the inherent dangers with this type of construction?
- What are the fire conditions?
- Is there a potential for a backdraft or flashover?
- What are the immediate and long-term problems?

As can be seen, size-up is an ongoing process. When a proper size-up is performed, important points will not be overlooked and the incident scene will be run in a professional manner.

Level 3: Strategy

Strategy should be viewed as *overall goals or what you want to accomplish on the incident.* An Incident Strategy is defined as a plan of action (POA). There are seven basic strategies listed in priority order of consideration at an emergency below:

1. Rescue
2. Exposures
3. Confinement
4. Extinguishment
5. Overhaul
6. Ventilation
7. Salvage

This is remembered using the anagram RECEO-VS let's look at each area:

Rescue

- Where are the occupants?
- Who are the occupants?
- What is the best way to protect or rescue them?
- Attack & extinguishment of the fire will save more lives than any other strategy on the fireground

Exposure

- *Impossible to overemphasize*
- Enter and inspect all possible areas of fire entry
- Open those areas suspected of containing hidden fire
- Don't be tentative

Confinement

- Confine the fire to as small an area possible
- The path it will most likely travel must be considered
- This allows the IC to predict what problems must be overcome to achieve confinement

Extinguishment

- Involves knocking down all visible fire and hidden fire exposed during the overhauling stage
- Judicious use of hoselines
- Indiscriminate use of water causes needless damage
- When a fire has been controlled, sprinkler systems should be shut down

Overhaul

- Ensures that all fire has been extinguished
- Critical step in complete extinguishment
- Use experience and training when opening walls and ceiling; don't cause unnecessary damage
- Often occurs simultaneously as part of fire attack (opening ceilings and walls)

Ventilation

- Utilized whenever it is needed during the course of firefighting and not at one set juncture
- Allows intervention of hose-line crews to effect extinguishment
- May also be performed during rescue stage to draw fire and smoke away from trapped occupants

Salvage

- CUSTOMER SERVICE
- Could pay huge dividends with public relations if completed successfully
- Lessens the amount of the loss by protecting items from damage caused by smoke and water
- Begin ASAP

Revised Structural Fire Tactical Goals

In recent years a new set of fire tactical goals have been developed that can be substituted for RECEO-VS. These new goals were developed to compliment the fire behavior studies conducted by Underwriters Laboratories (UL) and the National Institute of Standards and Technology (NISI). These new sets of goals are provided to allow for variety of options for establishing tactical goals.

There are two anagrams to know: S.L.I.C.E.R.S. and D.I.C.E.R.S. We will give each anagram and then discuss their concepts and traits further.

S.L.I.C.E.R.S. -A fire attack mode tactic used to reduce temperatures inside a building prior to entry by firefighting personnel for extinguishment or rescue and is broken into two categories.
1. Sequential actions
2. Actions of opportunity

Sequential Actions
Size-Up
Locate the Fire
Isolate and Control the Flow Path
Cool the Space from the Safest Location
Extinguish the Fire

Actions of Opportunity
Rescue
Salvage

D.I.C.E.R.S. is a fire extinguishment model utilizing interior tactics to extinguish fires.

Sequential Actions
Detect the Location of the Fire
Isolation of the Fire Area
Confinement of the Fire
Extinguish the Fire
Rescue of Those Affected by Smoke and Fire
Search of the Fire Area and Adjoining Spaces

Ventilation Coordinated from Within
Overhaul of the Fire Area for Hidden Extension

Leve1 4: Tactics
While an Incident *Strategy* is defined as a plan of action (POA), an Incident *Tactic* is defined as how an assignment will be accomplished by a deployed resource. For instance, if ventilation is the strategy, then the tactic could be "horizontal and vertical ventilation over the fire area."

Multiple tactics may be needed to achieve a strategy. For example, to enter the building for confinement or search and rescue, it may be necessary to use forcible entry, place ladders to upper floors, or stretch hoselines.

Tactics must be measurable and specific in order to know when they have been accomplished.

"Place water on the fire."
"Stretch hoseline to second floor and confine the fire to area involved."

Level 5: Tasks

Tasks are implemented by giving orders to the units that will carry out the tactical operations. To be effective, the initial incident commander must describe who is going to do a task and when they will do it. The initial incident commander must determine whether there are sufficient resources to handle the current and anticipated problems.

Successful Operations

Strategy and Tactics are not an exact science. The initial IC may be faced with limited resources and minimal information. The demands of the scene need to be prioritized to ensure the maximum utilization of available personnel. Certain actions can be achieved with the limited resources initially available. Therefore, certain tactics, such as extinguishment of the building on fire may seem to be the priority, but the amount of resources available may make protection of exposures more advantageous. When adequate personnel arrive, implementation can be expanded to address all aspects of the plan.

Initial incident commanders must constantly evaluate and re-evaluate our situation.

Risk Management

In order to understand risk management we must define the terms *risk, hazard,* and *risk management.*

Risk- the possibility that something bad or unpleasant (such as an injury or a loss) will happen

Hazard – something causing danger, peril, risk or difficulty

Risk Management- using resources, experience and training to minimize acceptable risk taken by emergency responders

Risk management is an essential part of emergency planning. The initial incident commander must determine the amount of risk they are willing to take based on incident conditions.

As a baseline model:
Risk a lot to save a lot
Risk a little to save a little
Risk nothing to save nothing

No building is worth a firefighter's life

Risk management begins during the preplanning phase and continues throughout the incident. This is why the initial incident commander must know their immediate response jurisdiction in addition to having a constant incident situational awareness.

As part of the continuing incident risk assessment, the initial incident commander should perform a visual scene assessment.

- What is the type of construction?
- What is the occupancy of the affected structure?
- What stage is the fire in?
- Is the structure vacant or occupied?
- Signs of occupancy or verbal confirmation
- Time of day

Safe and Effective Incident Operations / Safety

Command is responsible for overall management of the incident, establishes the strategy and tactics for the incident and most importantly, and is responsible for firefighter safety. Safe and effective incident operations require someone to be in command, resources assigned to a task to stay intact, and tracking of all resources.

If the Incident Commander (IC) does not appoint a Safety Officer, then the Incident Commander (IC) is responsible for safety. The Safety Officer is responsible for monitoring and assessing safety hazards.

No matter how significant the fire , only a finite amount of protection is afforded to firefighters in full personal protective equipment (PPE) and self-contained breathing apparatus (SCBA). Incident commanders and firefighters alike should keep in mind that the weakest link in structural firefighting PPE is the face-pieces which have been known to fail at 500°F or above.

Collapse Hazards

Any building under fire conditions can suffer a catastrophic collapse. However, structural collapse becomes very likely in the decay stage when the products of combustion have significantly impacted the structures ability to resist gravity. Renovation, age of the structure, weather, and loads are all structural collapse factors. Additionally, 8.33 pounds (3.69 kilograms) of water is added to the weight of floors for every gallon of water applied during fire department suppression operations. These two factors (significantly impacted structural integrity and large amounts of water delivered into the structure) can have a negative impact on structural integrity.

Sounding the floor above a fire is not a good indicator of the floor stability and while thermal imaging cameras are good for gathering information on the location and extent of the fire, they generally cannot be used to determine structural integrity.

Incident commanders should consider establishing collapse zones around the structure when defensive strategies are adopted. These collapse zones should be adjacent to any exposed exterior walls.

If needed, personnel may cautiously place an unstaffed master stream in the collapse zone when the incident commander deems it vital, and a collapse may be imminent.

Common Factors for Injuries and LODD's

The following are common factors for injuries and line of duty deaths (LODD):

1. Guidelines, Policies and Procedures do not exist or not updated
2. Guidelines, Policies and Procedures weren't followed (Lack of training on existing
3. documents)
4. Lack of Incident management
   a) Command was not established
   b) Agencies fail to provide adequate training on establishment of command
   c) Incident objectives overwhelming the IC
   d) Exceeded span of control

Could be due to scope of the incident or inexperienced IC

Lack of Communication can cause freelancing or multiple commands

- IC to Interior crews
- Between mutual aid companies

All responders should have a portable radio

The initial incident commander should consider evacuation if communications are lost with interior crews

Lack of experience
Either a lack of overall fire scene experience or a lack of experience with the type of structure
Unable to use RPDM

May result in lack of confidence among crews

Personnel Unfamiliarity

- With crew or mutual aid companies
- Unsure of capabilities

Other factors

- Begin aggressive interior operations before RIT crews are staffed and equipped
- Failure to reassess incident conditions frequently

These common factors are not often singular; usually these factors are cascading, multiple factors in play at incidents with catastrophic results. Many times these factors can be remedied through effective pre-incident planning and training and through effective situational awareness.

Agencies must have adequate and updated policies/procedures
Agencies must have an aggressive training program

- Training on policies and procedures
- Training for new officers on expectations
- Training for all initial and potential initial incident commanders
- Cross training with mutual and automatic aid companies and departments
- Effective development of strategy and tactics

Unit 5 Communication and Size-up

Lesson Goal

Communication and size-up are very important to the strategy and tactic process. The goal of this module is to list and define the different benefits of effective communications and to define and demonstrate effective size-up techniques.

This material was developed out of the National Fire Academy Curriculum.

Incident Communication

Benefits of Effective Incident Communication

There are many benefits to effective incident communications, namely, improved firefighter safety; effective use of resources, and improved interagency cooperation and the always present legal implications.

Reports that must be communicated effectively may include initial size-up reports; tactical benchmark reports; and progress reports.

Personal Safety

Effective incident communication fosters a good development of overall strategy and tactical objectives by allowing others on the incident to provide the initial incident commander with information they may need to develop the initial action plan. Once developed, effective communication will allow better coordination of the strategic and tactical objectives.

Since incident scenes are often vast and create working locations out of the initial incident commander's sight, effective communication allows the initial incident commander to know where personnel are at all times. If an emergency were to occur, the initial incident commander can quickly be advised and advise others of any safety hazards that may exist on the scene.

Effective Use of Resources

Clear communication eliminates confusion and gives personnel the scene of an incident defined boundaries in which to operate. Effective communication will ease or eliminate the threat of freelancing.

As the incident progresses, the incident commander is apprised of changing conditions through the use of periodic updates between the initial incident commander and incident personnel.

Improved Interagency Cooperation

Effective communication between two or more agencies is extremely important, especially on high-risk incidents. In addition to making each department appear more professional, by clearly communicating goals and objectives, other agencies will be better able to understand your needs. This will eliminate duplication of efforts and foster a good attitude among responders.

Legal Implications

The legal ramifications of incident management are ever-present. Not only are most fireground communications channels recorded, but many times others are listening and / or recording the incident as it unfolds.

The initial incident commander must always keep in mind that communication recordings, whether collected by the agency or a private source could be submitted as evidence. All departments must follow Federal Communications Commission (FCC) licensing requirements and any local ordinances.

Effective Communication

Choose your words wisely. Words often are used to describe multiple things. Regional or generic terms can have different meanings. For example, the word "Gator" brings to mind different things in different contexts. If a person is on a farm or working a public safety event and hears the term "gator" they may think of an all-terrain utility vehicle manufactured by John Deere. If a person were hunting or in Gainesville, Florida at the University of Florida and hear the term "gator" they may think of large man-eating reptile.

Different Ways to Communicate

The different ways to communicate on an incident are many, and continue to grow. Whereas the only way to communicate 25 years ago was via a bull-horn or face to face, today's technology allows us to communicate on an incident in many different ways. These include:

- Face-to-face
- Mobile radio
- Cell phone

In addition to communication devices, responders on the scene of the incident may also use the incident action plan (lAP) as their communication tool. The lAP will communicate the objectives and tactics to the responder and assist them with making good decisions and executing proper actions.

Fire ground communications is more than just yelling orders. Effective incident communication involves giving *and* receiving pertinent information. This information must be relevant to the incident and initial incident commanders should enforce this policy. Additionally, the information presented and shared should be understood by all parties. This would include using plain English and avoiding slang or regional terms. Any confusing or misunderstood communications should be repeated.

SIZE-UP

A size-up is an evaluation of problems and conditions that affect the outcome of the emergency. Whether it is verbally transmitted to other incoming resources or not, every incident will receive some form of a size-up.

Proper size-up begins from the moment the alarm is received until the emergency is under control. Every responder, to a degree, will perform their own size-up on the way to the incident.

Different resources will respond from different locations, and those resources will have a different aspect or responsibility that will affect their size-up. For example, a fire engine responding to the incident will be considering water supply, hose size and length, whereas an EMS unit responding will be considering patient potential, the location of the nearest hospital, etc.

Once on scene, the initial incident commander must do a proper size-up. This will mean walking around the incident gathering information. This could include:

- Time of Day
- Incident Location and occupancy type
- Weather
- Nature of Emergency
- Topography
- Water Supply Quantity & Location Size of Structure
- Fire and Smoke Conditions as well as an estimated bum time
- Building Involved & Time of Involvement
- Determining occupant life safety issues (Firefighter & Civilian)

Size-Up Factors

There are five factors to effective size-up:

Step 1: Analyze the Size-Up Factors
Step 2: Establish Major Incident Objectives
Step 3: Identify Incident Strategies
Step 4: Assign Incident Strategies
Step 5: Evaluate Incident Strategies

To assist initial incident commanders there are three anagrams / acronyms that are nationally recognized to help with remembering the factors for size-up. These are listed below and will be discussed for in depth following:

C.O.A.L. W.A.S. W.E.A.L.T.H.
W.A.L.L.A.C.E.W.A.S. H.O.T.

COAL WAS WEALTH

COAL WAS WEALTH and WALLACE WAS HOT are the two more recognizable anagrams / acronyms for size-up. Both share the same factors placed in different locations in each. It is important to remember that neither of these two anagrams are organized in order of priority.

Construction

Knowledge of building and building construction will enable the IC to enact the proper strategy and action plan

Fires spread in relatively predictable patterns in the different types of building construction

Occupancy

Occupancy can clue firefighters in to such factors as:

- Fire load
- Hazardous Materials
- Life Hazards

Knowing what and who are inside a building is one of the critical keys to the life hazard problem. One of the major problems with occupancy might be heavy content fuel loading. In these structures, incident commanders and firefighters will find large amounts of material that under fire conditions will make a minor situation very bad very quickly. The most effective defense against heavy content fuel loading is proper inspection and code enforcement.

Apparatus and Manpower

The success or failure of an operation depends, to a great degree, on how well you manage apparatus and manpower

Apparatus considerations will be different for Career departments vs. Combination departments vs. Volunteer departments

Life Hazard

#1 Priority; responders will come first, occupants second

The degree of life hazard usually isn't ascertained until arrival

- Pre-planning can help clear up the unknowns

Water Supply

Without sufficient water, the game is over before it begins

- Proper hydrant spotting; know which side the hydrant will be on and what they look like
- Thread types and hydrant wrenches; do you respond to areas that require different hydrant wrenches?

Auxiliary Appliances

Critical factor to consider when determining strategy and tactics

- Does the building have a sprinkler system
- Does the building have a Standpipe system, if so, what class
- Fire pumps and how to access them
- Fire Command Centers and how to access it

Street Conditions

Knowing the quickest, safest way to get to an alarm is important. Sometimes the most direct route isn't the fastest. Know which streets to avoid especially ones that are seasonally crowded or have weight or height restrictions

Weather

Almost impossible to preplan the weather, but it CAN be done. Weather preplanning can be effectively done in wildland situations where departments call in additional resources during times of severe fire weather danger

Exposures

After Life Hazard, exposures are our 2^{nd} priority

Many of the concerns from the fire building transfer to the exposure

It's important to size-up the most severe exposure vs. the most severely threatened exposure

Area and Height

Area

- Large buildings require long hose lays
- Set back homes will also require long hose lays
- Other distances (i.e. railroads) will effect things
- Some areas are unfriendly, even to firefighters
- "Dead" spots for radio communication

Height

- High-rise buildings have their own unique set of challenges, but also have built-in protection features.
- Some buildings will be out of reach of even the longest ladders.

Location and Extent

No action plan can be set into motion until the location and extent of the emergency is determined

Car fire on the street is a problem

Car fire in a below-grade garage is a <u>BIG</u> problem

Estimating the bum time will assist an initial incident commander with determining victim viability and structural integrity. In determining the bum time for safe operating timeframes on an incident, the incident commander must consider when the fire began, or more exactly, when the ignition occurred.

Time

Like weather, another tough one to tackle since we never know when a fire or emergency will occur

Our knowledge of occupancies will assist us in determining how much time effects our operations

Hazardous Materials

The IC cannot afford to become a victim of the tunnel vision syndrome and let his guard down

With any report of hazardous materials, the responders should remain uphill, upwind and isolate the area

LFO, Life Fire Operations

The third size-up anagram / acronym is Life, Fire, Operations or shortened, LFO. LFO simplifies the process and is ideal for initial incident commanders whose focus is getting operations up and running before a more elaborate size-up is conducted.

Life

What time of day is it?

What type of occupancy is it?

Given the amount of resources

Fire

What is the fire doing and where is it?

Is the fire big or small?

Operations

What does the initial incident commander's department's S.O.G.s dictate should be done given the situation

Scene Size-Up and Radio Reports

The initial incident commander's first radio traffic is more than just another elegant radio transmission. This transmission is the initial incident commander's first early assessment of the situation, or rather, an interactive snapshot of the incident.

It is important to understand that every incident is unique and dynamic. What the first unit on scene or the initial incident commander sees many change instantaneously so it is important to give accurate information and "paint the picture" effectively from the onset.

One may ask why this radio transmission is so important. This transmission forms the foundation for initial actions and creates building blocks for command. Not only does this transmission give all responders an idea of what to expect when they arrive, it provides guidance for later arriving apparatus as to actions that may need to be taken.

Again, the first arriving unit, person, or initial incident commander must paint a good picture of the scene. Think of the report in terms of Who, What, When, Where, and Why.

Who gives the initial size-up?

First arriving officer or personnel
Everyone else

What information is relayed?

Collection of information
Relevant information
Understood by all responding

When is this done?

Anytime you are in district
When dispatch is transmitted

Where do I direct my information?

Primary District
Mutual aid District
On Scene

Why do I do this?

So that others might understand potential challenges you are encountering or seeing

Size-up Report

Make Sure Dispatch is Listening!

Describe Occupancy

- Size (20X30, 30X50, small, medium, etc)
- Height (1, 3 stories, etc)
- Occupancy Type (residence, hotel, warehouse, etc)

Describe Problem

- Nothing Showing
- Smoke Showing (light, heavy)
- Working fire (fire from A side, second floor)
- Defensive Fire Conditions

Location

- Division 1, 2, 3, etc.(1st, 2nd,3rd floor)
- Division Alpha, Bravo, Charlie, Delta.

Objective

- Life Safety (Search and Rescue)
- Incident Stabilization (Fire Control)
- Property Conservation

Size-up Report cont'd

Established Strategy
- Offensive
- Defensive
- Combination
  - Strip Mall
  - Apartments

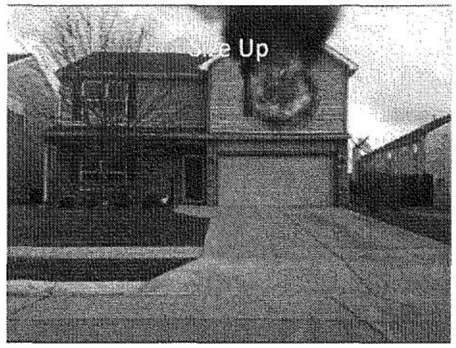
Establish Command
- Street name
- Occupancy Type

Incident Action Plan
- Task
  - Investigate
  - Perform a rescue
  - Lay a supply line
  - Stretch an attack line
  - Blitz attack
  - Search
  - Ventilation

Working Incident

Along the way, you will hear the term "Working Incident." This is a plain English term used to identify that the initial incident commander believes that the incident is at a point where the units assigned will mostly be given tasks rather than be disregarded.

Fire Control E-1
GoAhead E-1
E-1 on the scene of a small, 1 story residence with smoke showing on the Alpha side. E-1 will be laying a supply line and stretching an attack line. E-1 is establishing Grant Street Command. Mark this a working incident.



Follow Up Report

A follow up report can be given to incoming responders when more information is gathered. For example, if the initial incident commander, through reconnaissance, is notified that the fire is in the basement on the back side of the structure they may give this follow up report.

Command to all units responding… Fire is located in the basement on Charlie side… E-1 will be re- deploying the attack line to Charlie side.

Unit 6 Rescue Considerations

Lesson Goal

The goal of this unit is to assist initial incident commanders with developing appropriate rescue tactics based upon incident conditions and using identified rescue principles and tactical considerations. Initial incident commanders, using the command sequence cycle should be able to develop a rescue action plan based on the incident presented.

Rescue

Rescue is defined as a systematic process used to locate, protect, and remove occupants and fire victims safely from a structure and convey them to a place of safety.

Rescue Tactics

When resources and fire conditions allow, the initial incident commander must conduct a systematic search of the structure. This search is done in three tactics:

- Primary search
- Secondary search
- Provide for the rescued occupants

If a victim is found, the search and rescue crew must provide for rescued occupants, and the initial incident commander must request resources, such as EMS to respond to the scene.

Primary Search

A primary search is a rapid search of all areas involved in or exposed to fire, if they can be entered, to verify removal and/or safety of occupants.

The key phrase here is rapid. This search covers those areas of the structure where viable victims *might* be located. During the primary search, the search crews are also working to discover the location and ***I*** or seat of the fire. Firefighters conducting a primary search would look at routes normally used to enter and exit the structure; behind doors and under windows, and in bedrooms.

Once the primary search has been completed the search crew will give transmit "Primary Search All Clear."

Secondary Search

A secondary search is an extremely thorough search of interior fire area. This is conducted after the initial incident commander has declared the preliminary fire control, ventilation, and interior lighting are completed.

The key phrase here is extremely thorough. This search covers the areas that were bypassed during the primary search for various reasons and ensures that there is no possibility of victims remaining undiscovered.

Provide for Rescued Occupants

In addition to *search* for victims, the search crews must remove and provide for any rescued occupants should they be found. This includes identifying victim removal paths. The ideal removal path is via the interior stairs with a firefighter escort. The least attractive method of removing victims is via aerial or ground ladders. No matter what method is used, it is important to move the victims to a triage area that will provide for the uninjured, and **/** or transporting the victims.

Tactical Size-Up for Rescue

Rescue of occupants is a very dangerous endeavor and must be thoroughly sized-up by the initial incident commander. Size-up factors include:

Stage of fire development

- What stage is the fire in? Has the fire progressed to the point where there would be no viable victims?

Location of fire

- What is the location and extent of the fire; do I have enough resources available?

Number, location, and condition of victims

- How many victims do I have and do I have the proper amount of resources responding or on scene?

Capability of on-scene companies

- Are my crews up to the task? Some fire crews will not search as well as some other crews. The initial incident commander must consider the experience, and education of the fire crews on scene.

Search with or without lines?

- Searching with or without lines will be based on the experience and capabilities of the search crew.

Size-up Questions

The initial incident commander must have the following information in order to make good tactical decisions.

Rescue

Are victims confirmed? Of the victims confirmed are any viable?

Occupancy I Time

What type of occupancy is this? What time of day is it and will that have an effect on operations?

Location and conditions of fire

Where is the fire and what is the fire doing?

Building construction type

What type of building is this? Does this building work to my advantage or detriment?

Ventilation

Is ventilation advised or necessary?

Hazards

What hazards are present?

Support for Rescue Operations

Support activities include:

- Controlling utilities
- Providing compressed breathing air
- Providing scene lighting / electricity
- Providing for rehabilitation / rehydration and medical monitoring / treatment

Additionally there are a number of ways the initial incident commander can support search and rescue.

- Protective lines
- Entry
- Ventilation
- Laddering
- Confinement/Extinguishment

Rescue Coordination Issues

Teamwork, organization, and good communication are paramount for a successful rescue mission. The initial incident commander must foster these points in their search and attack crews. Additionally, the initial incident commander but be reevaluating the incident every step of the way. The IC must ask themselves whether or not ventilation will hurt or help rescue efforts. Search crews must learn to keep fire away from people and protect escape routes with hoselines. DO NOT PUT PEOPLE IN THE FLOW PATH. Laddering can provide a secondary egress and advance protective hoselines.

Is confinement/extinguishment the best chance for victims?

Summary

Incident conditions, amount of fire involvement, and resources available will drive decisions. What may be done in one jurisdiction may not work in another, so it is important for the initial incident commander to be fully aware of what is happening with the fire and structure. The evaluation of rescue potential must always remain in the forefront of the initial incident commander's mind.

Unit 7 Ventilation

Lesson Goal

The goal of this unit is to assist initial incident commanders with developing appropriate ventilation tactics based upon incident conditions and using identified ventilation principles and tactical considerations.

Definition

Ventilation is a planned, systematic procedure for reducing, redirecting, or removing heat, smoke, and fire gases from a structure and replacing them with clean, fresh air.

The primary objective of ventilation is to localize the fire--to stop its horizontal spread within a structure. Additionally, effective ventilation facilitates the advance of hoselines.

When done properly ventilation can save lives and property, improve interior conditions, and make support activities more efficient. When done improperly ventilation can intensify the fire and cause rapid deterioration of interior conditions.

The traditional belief is that adequate ventilation will clear the interior, improve victim chances of survival, and allow interior crews to reach the fire faster. Unfortunately, many perform ventilation without considering the incident conditions. To dispel a common myth; ventilation does not need to be performed prior to making entry into the structure.

Research conducted by the National Institute of Standards and Technology (NIST) and Underwriter's Laboratories (UL) have taken an in-depth look at fire behavior and the effects of fire department ventilation during structure fires.

Modern Content Fires

Modem content fires reach a stage of flashover potential much faster than previous content fires did. Because fires of these types grow much quicker, they have often used up much of the available oxygen prior to the fire departments arrival and are simply waiting for firefighters to open the structure up and provide additional oxygen. Therefore, the smoke within the structure should be considered an unburned fuel just waiting to ignite.

This means that content fires will transition to flashover prior to our arrival or become ventilation-limited waiting on air via a ***flow path*** (such as opening doors or windows by fire crews).

Flow paths can be defined as the movement of heat and smoke from the higher air pressure within the fire area to all other lower air pressure areas both inside and outside of a fire building.

Therefore the most modem content fires can be considered ventilation limited and when firefighters start to open doors or take out windows the fire will intensify; heat within the structure will rise, and interior conditions may deteriorate rapidly. A classic sign of a ventilation limited fire is little or no smoke.

The incident commander must have crews ready to apply water when these *flow paths* are created.

In summary, ventilation should be controlled by the Incident Commander and coordinated with interior crews. Before the incident commander orders ventilation, they ensure that the situation warrants the tactical ventilation and must have the proper amount of resources on scene.

TIMING is everything.

Ventilation Principles

There are several established reasons why the initial incident commander would consider ventilating the structure.

- Ventilation for life safety
- Ventilation for incident stabilization
- Ventilation for property conservation
- Ventilation to support other tactical operations

Why we ventilate

There are two main reasons why we ventilate.

- Ventilate for life or life safety; to remove smoke from an environment to aid in survivability.
- Ventilate for fire or property conservation; to remove smoke from an area or to prevent fire spread.

Ventilation Avenues

- Horizontal ventilation, where windows, doors and other openings in the horizontal plane are opened.
- Vertical ventilation, where roof vents, skylights, bulkhead doors, and sometimes the roof itself are opened.
- A combination of both horizontal and vertical ventilation

Ventilation Methods

There are two accepted methods to ventilate a structure:

- Natural ventilation
- Forced (mechanical) ventilation which could include:

✓ Negative pressure
✓ Positive pressure
  ✓ Hydraulic Ventilation (Fog streams)
  ✓ Building heating, ventilating, and air conditioning (HVAC) system

Ventilation Considerations

Each building type will require a different ventilation consideration.

Fire Resistive
Non-Combustible
Ordinary Construction
Heavy Timber Construction
Wood Frame

Each type of occupancy will require different ventilation considerations

Single Family One-Story
Single Family Multi-Story
Multi-Family Multi-Story
Multi-Family Garden Style / Row House

Commercial Occupancy - One Story
Commercial Occupancy- Multi-story
Commercial Occupancy- Strip Mall
Commercial Occupancy- Office / Professional Building
Commercial Occupancy- Warehouse / Manufacturing

Developing a Ventilation Action Plan

ICs and fire fighters must consider the Who, What, When, Where, and Why to ventilate:

Who will ventilate (knowledge and skills)?

- Of the resources I have, what is my best option?
- Of the options I have, what provides the best gain vs. risk?

What type of ventilation?

- Through your size up, what type of building are you presented with, and what type of ventilation is required?

When and Where to ventilate?

- Opening up below, on the same level or in the wrong place can have a detrimental effect on fire conditions, and cause fire to spread in unintended directions. This was one of the challenges noted in the 2012 Muncie Fire Department Line of Duty Death

Why ventilate?

- Is there a need to ventilate?
- If the structure is already venting fire, will opening up the structure further help or hurt the situation

Unit 8 Confinement / Extinguishment and Exposure Protection

Lesson Goal

The goal of this unit is to describe the proper techniques needed to safely and efficiently confine, extinguish and protect exposures. This unit will also help the student select and deploy the appropriate hoselines to accomplish fire confinement, exposure protection, and fire extinguishment; develop a confinement action plan based on the incident presented; develop an exposure protection action plan based on the incident presented; develop a fire extinguishment action plan based on the incident presented; and identify and explain the actions required to support fire confinement, exposure protection, and fire extinguishment activities.

DEFINITIONS AND PRINCIPLES

Fire Confinement

Those actions taken to confine a fire to a given area of present involvement by preventing the spread of fire into any uninvolved area.

Fire Extinguishment

Those actions taken following fire confinement to extinguish a fire by removing the fuel, air supply, or, most commonly, the heat.

Basic Fire Flow Formula

The basic fire flow formula for one floor is the length of the building multiplied by the width of the building divided by 3. The basic fire flow formula is expressed in this formula: (LX W)/3

Principles of Fire Confinement, Exposure Protection and Extinguishment

The major objectives of fire operations are to confine, control and extinguish the fire. The principles of this unit are simple; keep fire from extending into an unburned area. This may seem like a simple idea, but when you consider the building or compartment where the fire is and its distance from the fire apparatus; the available manpower and other resources, and the severity of the fire the simple will become complex.

Fire Confinement Tactics

One of the first goals should be to confine the fire to its location as found by the initial arriving units. There are a number of reasons we do this:

- Assist with search and rescue
- Awaiting additional resources
- Save portion of structure
- Prevent fire extension

Size-up for confinement

As with any other aspect of initial incident management, it is important for the team assigned to confining the fire to discover the location and extent of the fire. To do this, the team must have an idea of the building construction type and occupancy, the fire flow requirements for this particular structure and whether or not any fixed suppression equipment will assist or hinder operations.

The attack team must be aware of resources that may or may not be available, and what type of coordination may be required with other teams, such as water supply, ventilation, or search and rescue.

Selection of the Proper Hoseline and Nozzle for Fire Confinement

By confining the fire, the initial incident commander can hold its spread in check and prevent further destruction while other tasks such as search and / or rescue are completed. Selecting the proper hoseline and nozzle for confinement is just as important of locating and evaluating a fire.

In order to confine the fire the initial incident commander is going to have to put the proper sized hoseline into position. This hoseline must first *reach* the fire. This means that the attack team must select a hose long enough to reach the fire. The second factor is stopping power. Many attack teams select hoselines or nozzles that do not produce enough extinguishing agent to effectively confine or extinguish the fire. Most of the time, smaller lines are selected on basis of speed and not stopping power. A wise incident commander once said, "Adult fires deserve adult water."

The attack team leader must select the proper hoseline for the fire. That hoseline must at least reach and defeat the fire, or at least keep it in check. (See Basic Fire Flow)

What Incident Objectives Can Be Accomplished?

Now that the initial incident commander has placed a hoseline in a position to contain and / or control the fire to room/ building of origin, we can consider other incident objectives such as rescue or ventilation.

Implement the Fire Confinement Plan

In implementing a fire confinement plan, communications is key. There is a fine line between fire confinement and fire extinguishment and it is important to make the initial incident commander's intentions understood. Good communication will help keep overly aggressive attack teams from trying to do too much with too little resources.

Once the fire confinement action plan has been implemented the initial incident commander should expect or request progress reports from resources operating on the incident roughly every 10 minutes.

Exposure Protection Tactics

Exposure Protection Definition

In addition to confining the fire to the point of origin, initial incident commanders should also consider confining the fire to the room (and sometimes, the building) of origin. This is considered exposure protection.

Exposure protection is defined as the tactical operations performed to protect exposed property and areas near the fire from becoming involved. Exposures can be internal (within the building) and external (exposures surrounding the building)

When the initial incident commander is presented with a heavy volume of fire and little initial resources, exposure protection may be the only tactical option. If needed, personnel may cautiously place an unstaffed master stream in the collapse zone when the incident commander deems it vital, and a collapse may be imminent.

Principles of Exposure Protection

There are three principles of exposure protection:

- Protect external exposures
- Protect internal exposures
- Protect areas downwind from the fire

The initial incident commander must prioritize the exposures based on the amount of radiant heat, or in some cases the potential for radiant heat. There are three methods of transfer of radiant heat:

Point source

A point source fire is a small localized fire/room and contents, such as a couch or chair. Doubling distance from a point source fire reduces radiant heat to approximately 25 percent.

Line Source Fire

A line source fire is a fire burning in a long line such as a brush fire/running flammable liquid fire. Doubling distance from a line source fire reduces radiant heat to approximately 50 percent.

Area Source Fire

An area source fire is a fire burning in a long line such as a large wild land fire (crowning)/totally involved structure fire with the structure itself burning. Doubling distance from an area source fire reduces radiant heat to approximately 70 percent.

More radiant heat causes greater exposure problems. For example; if the initial incident commander is presented with a large fire, such as a lumber yard, then the radiant heat such a fire causes will be of great concern.

Prioritization Based on the Amount of Radiant Heat

The initial incident commander must select and prioritize exposures to be protected first. In some cases, the most severely threatened exposure isn't the most severe exposure. Preplanning is essential to determine most vulnerable and valuable exposures. A life hazard may make the task of covering exposures more difficult and may delay the attack on the fire itself.

Tactics for Protecting Exposures

There are several tactics that an initial incident commander could consider for protecting exposures.

Coordinated attack on fire with adequate flow is best way to protect exposures.

- Putting the fire out will solve all problems. When the initial incident commander has the ability to do so, then the focus should be on extinguishing the main body of fire.

Wash the face of exposed buildings with water to prevent ignition of exposed surface areas by reducing amount of heat absorbed.

- If the initial incident commander does not have the resources, then another option would be to place water or other extinguishing agent on the exposure.

Push fire back into original fire building to prevent extension to exposures.

- Another option would be to place lines in operation which push the fire back to the point of origin.

Reduce intensity or extinguish fire at critical points where heat transfer is threatening exposures.

- The initial incident commander could consider this option a "blitz" attack, whereas large caliber hoselines are used to "darken down" the main body of fire, therefore reducing the amount of radiant heat.

Support for Exposure Operations

There are a number of different ways the initial incident commander must support exposure operations. First and foremost, the exposure teams must gain access to exposed buildings and internal rooms to evaluate the fire spread or potential fire spread. This could mean laddering the building or forcible entry.

Additionally, the hoselines being used for exposure control must be supported with an adequate water supply.

Tactical Exposure Size-up Considerations

The initial incident commander must consider collapse potential and water supply needs when developing an exposure control plan. The initial IC must ensure that members operating on exposures are outside the collapse zones. Additionally, the appropriate amount of water flow must be provided. Large caliber streams and aerial devices will require greater than normal fire flows.

What Incident Objectives Can Be Accomplished?

Now that the initial incident commander has placed a hoseline in a position to contain and / or control the fire to room/ building of origin, we can consider placing other hoselines / manpower into position to extinguish the fire.

Implement the Fire Confinement Plan

In implementing the exposure protection plan communications is key. The initial incident commander will want to ensure that resources are being used to their potential and not being wasted on unachievable tactics. Good communication will help keep overly aggressive attack teams from entering collapse zones or from trying to do too much with too little resources.

Once the exposure protection action plan has been implemented the initial incident commander should expect or request progress reports from resources operating on the incident roughly every 10 minutes.

Fire Extinguishment Tactics

When fire confinement has been accomplished, fire extinguishment is the next tactical operation.

Fire Extinguishment

The purpose of fire extinguishment is to bring burning materials below their ignition temperature to stop flame production.

Size-up for Extinguishment

In order for the initial incident commander to extinguish the fire, they must know the location and extent. To do this, members will have to be sent into the compartment or area of origin to discover this. Access and egress to be compartment or area of origin must be evaluated.

This is where the initial incident commander must use good situational awareness; good decision making skills; and operate with a risk versus benefit mindset. If there are not enough resources to safely extinguish the fire, then confinement or exposure protection must be utilized.

Nozzle and Hoseline Selection

Selecting the proper hoseline and nozzle for extinguishment is just as important as locating and evaluating a fire. In order to put water on the fire the hoseline must first *reach* the fire. This means that the attack time must select a hose long enough to reach the seat of the fire. The second factor is stopping power. Many attack teams select hoselines or nozzles that do not produce enough extinguishing agent to effectively confine or extinguish the fire. Most of the time, smaller lines are selected on basis of speed and not stopping power. A wise incident commander once said, "Adult fires deserve adult water."

The attack team leader must select the proper hoseline for the fire. That hoseline must reach and defeat the fire, or at least keep it in check. If sufficient manpower is not on scene to complete this task, then other tactics should be considered. (See Basic Fire Flow)

Positioning of the hoseline

The position of the hoseline must be coordinated with other tactical assignments. This hoseline should be utilized to protect areas of access and egress, protect search and rescue efforts, and ventilation

The line doesn't necessarily have to be taken inside; new research has found that Fire streams applied from the exterior can improve interior conditions.

Safety Considerations

Everyone at the incident must operate safely and keep the Safety Officer informed of all safety concerns.

Given the danger of fire extinguishment tactics, the initial incident commander must consider the safety of the unit on scene. Therefore, they must consider whether or not a Safety Officer has been designated. If the IC does not establish and staff the Safety Officer position, the IC will also serve as the Safety Officer for the incident.

Basic Fire Flow Formula

In order for extinguishment operations to be effective, the initial incident commander must have a good idea of how much water is needed to extinguish the fire. This knowledge is gained by using the Basic Fire Flow Formula. The basic fire flow formula for one floor is the length of the building multiplied by the width of the building divided by 3. The basic fire flow formula is expressed in this formula:

$$(L \times W)/3$$

For example, a typical one-story home is generally 30 x 50 or 1500 square feet. By taking the length (30) and multiplying this by the width (50) we find the square footage of 1500 which we then divide by 3.

$$(L \times W)/3$$

$$(30 \times 50)/3$$
$$(1500)/3$$
$$500$$

So, this means we would need 500 gpm to effectively extinguish a fully-involved structure fire in a 1500 square foot (or 30 x 50) home. Knowing that our typical attack lines flow 200gpm we would need 3 attack lines and the corresponding number of personnel to man them.

Keep in mind, the majority of the building will not be fully involved; therefore we can further divide that 500gpm figure into smaller amounts.

So if only 25% of the structure was involved we would only need 25% of 500gpm (125). This means that one attack line (flowing 200gpm) plus one back up line would be more than enough.

Unit 9 Water Supply

Lesson Goal

The goal of this unit is to identify the principles of water supply and tactics for establishing water supplies using municipal sources, static sources, and portable sources. Further, after successful completion of this unit the initial incident commander or potential incident commander should have a better understanding of how to develop a water supply action plan based on the incident presented.

Definition of Water Supply

The tactical operation of providing sufficient water to meet needed fire flows at fire incidents.

Principle of Water Supply

The principle of water supply is to develop water supply adequate to support all fireground operations. This could be as simple as extending a supply line from a hydrant to a fire apparatus, to complex operations involving multiple engines.

Establishing a water supply may be achieved by using:

- Municipal sources
- Static Sources
- Portable sources

Municipal Water Supply Systems

It is important that an initial incident commander understands where their water is coming from. Whether it is from a hydrant or from water tender, effective fire suppression and containment operations will be dependent on some form of water supply system.

Municipal systems come in various forms and have various limitations. When using a municipal system it is important to know the quantity of water available at or near the fire. Small or dead- end water mains will hinder operations and leave the initial incident commander looking for water elsewhere. Relay pumping or water shuttle operations from hydrants may be necessary. This, of course, will require additional resources.

Static Water Systems

Static water systems will require more preplanning than municipal water supply systems. Responders will need to find water sources that have adequate access and water available. This information must be communicated to other units in the department and shared with mutual aid companies.

Portable Water Sources

Portable water sources such as tanker/tender apparatus will only be effective if they are able to quickly respond, dump their water, and refill to continue the cycle. While a large tanker may seem to be the most efficient purchase, if the tanker ***/*** tender cannot access the scene because of bridge-weight requirements, it will be useless.

Tanker / Tender Delivery Cycle

The Tanker / Tender delivery cycle is the time it takes a tanker/tender to set up, dump the water, travel to the fill site, fill up, and return. Once the initial incident commander establishes the required fire flow, the delivery cycle will need to be adjusted to fill the water supply needs of the incident.

Incident Tactics

The first water supply tactic will be to estimate the required flow rate. Once the flow rate is determined, a water supply plan must be developed and the assignments relayed to incoming units. This could be as simple as identifying hydrants that need to be connected or as complete as setting up dump and load sites for tankers / tenders.

Summary

The initial incident commander or potential initial commander must know their municipal water system capabilities and limitations. If the municipal system is unavailable or inadequate, the initial incident commander must determine your water supply plan and put it into action.